Measured Seafloor Penetrations of a Large, Free-Falling Cylinder and Comparison to Model Predictions

by

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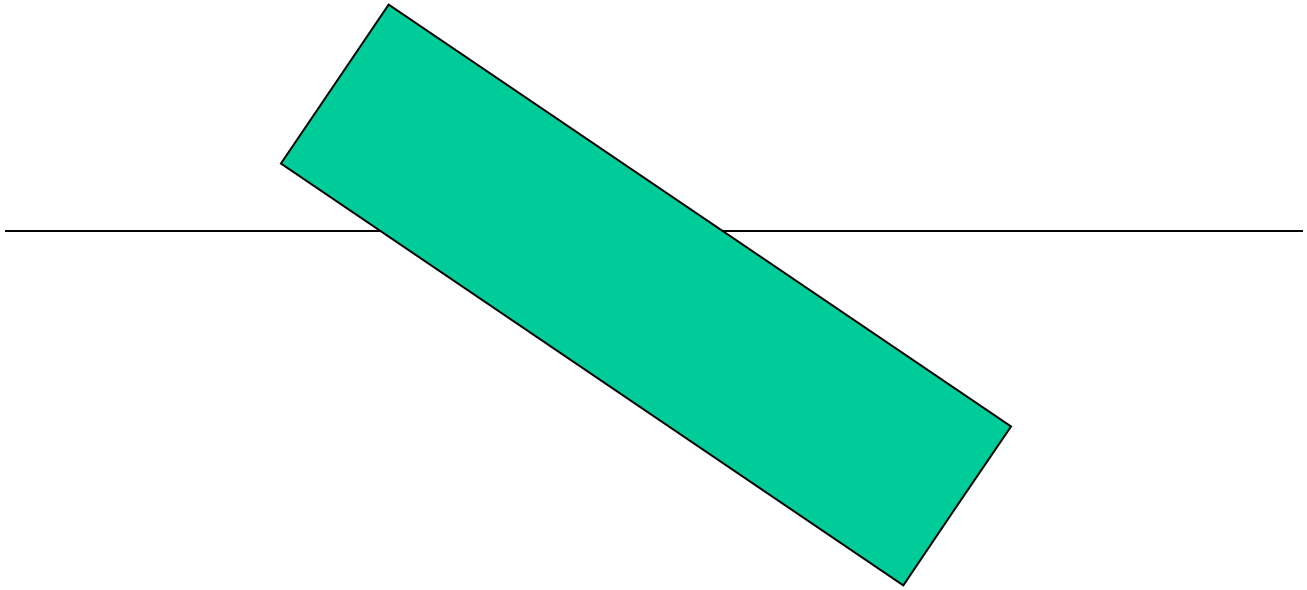
Measured Seafloor Penetrations of a Large, Free-Falling Cylinder and Comparison to Model Predictions

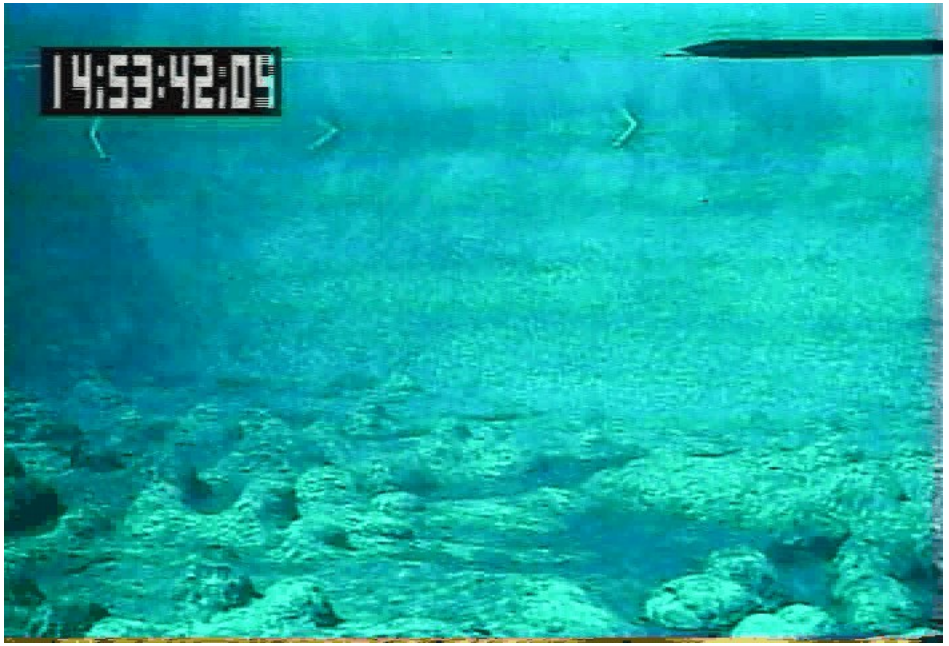
Project Objective: To predict height, projected area, and volume of bottom mines protruding above mudline



Existing Predictive Model…

- Solution is deterministic
- Neglects boundary layer effects
- 2-D, limits motion to vertical plane
  - disproven in at-sea experiments, September and November 2000
- Overpredicts penetration

3-D Motion in Water Column Illustrated in 1/3rd Scale Model Tests at NSWC Carderock Division



Double click on the above images to start the video clip

To gather data describing impact burial event in muds we needed:

- Sensors and data storage internal to model mine shell
  - To contain fiber optic gyro needed minimum shell outside diameter of 0.27 m
- Test site in lake or ocean

Designed and Fabricated Full-Size Instrumented Cylinder

- Diameter = 0.53 m
- Length = 2.40 m (L/D = 4.5)
- Weight in air = 10 kN (2,400 lbs)
- ‘Weight’ in seawater = 4.9 kN
- CM – CV = 0.104 m
- Three interchangeable noses: hemispherical, blunt, chamfered

Cylinder Instrumentation

- Fiber Optic Gyro
- Accelerometers
  - 2.5 g
  - 4 g
  - 10 g
- Magnetometer

Experiment Off Cocodrie, Louisiana, January 2002

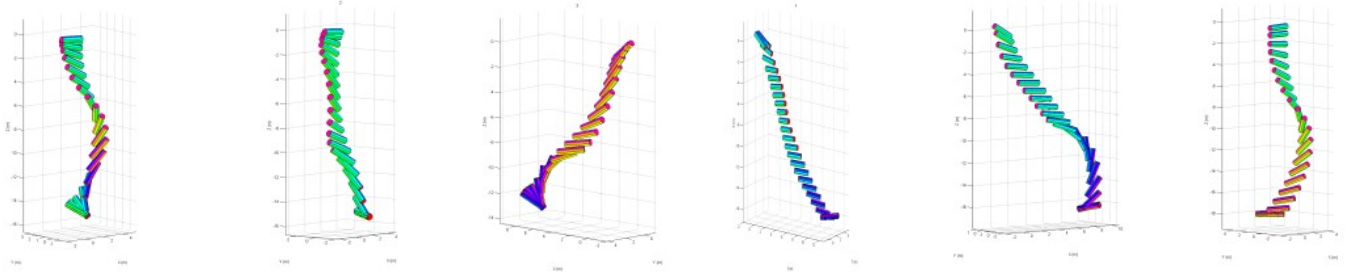
- Water depth: 15 m
- Distance above water surface: +1.0 or -0.5 m
- Pitch: horizontal and 45° nose down

Processed Data from Cocodrie Depict 3-D, Chaotic Trajectories

Water Depth = 15.5 meters

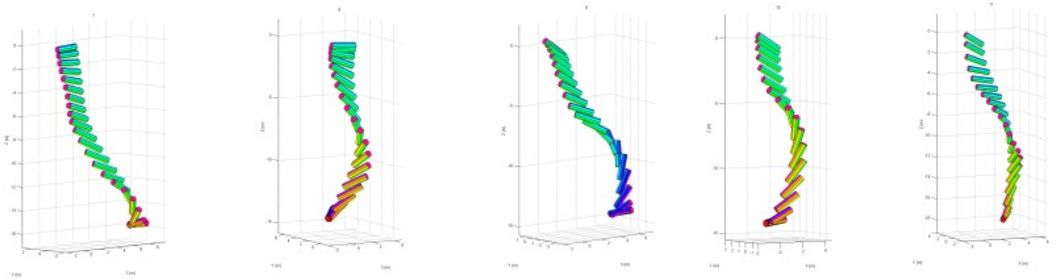
January 8, 2002

Drop #	1	2	3	4	5	6
Orientation	level	level	45º	45º	45º	level
Height (m)	-0.5	-0.5	-0.5	+1.0	+0.5	+1.0



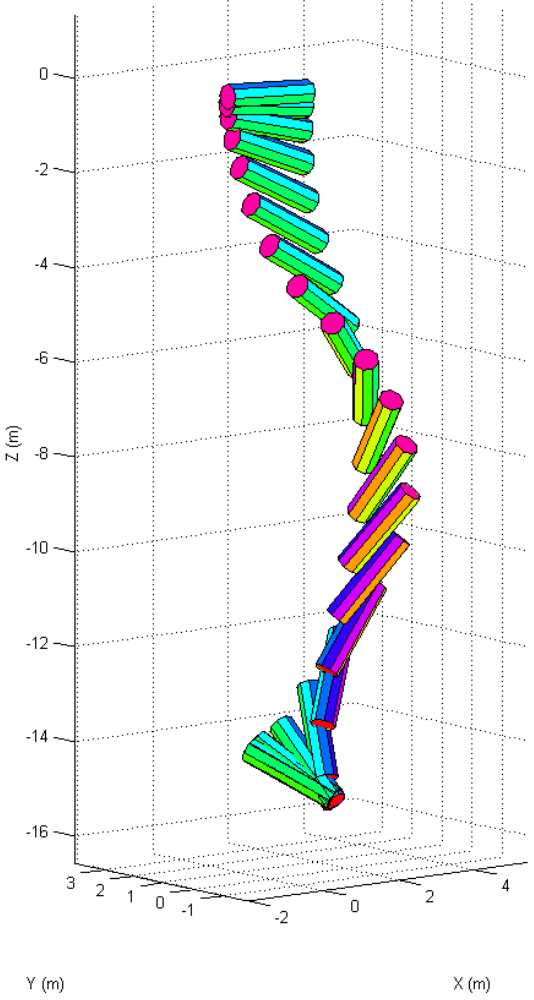
January 9, 2002

Drop #	7	8	9	10	11
Orientation	level	level	45º	45º	45º
Height (m)	+0.2	-0.5	-0.5	-0.5	+0.2

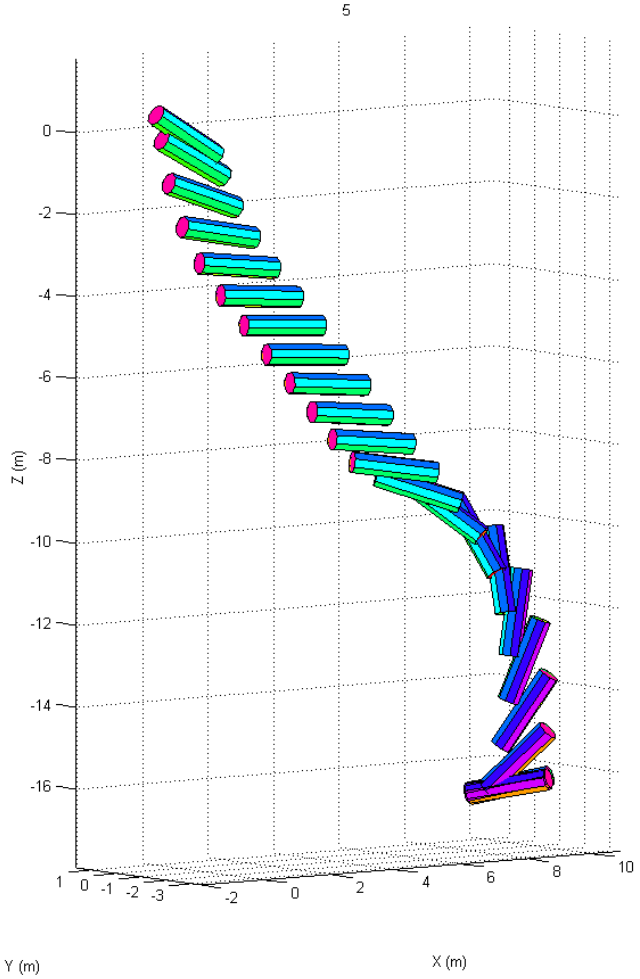


Processed Data from Two Cylinder Drops, Cocodrie, LA

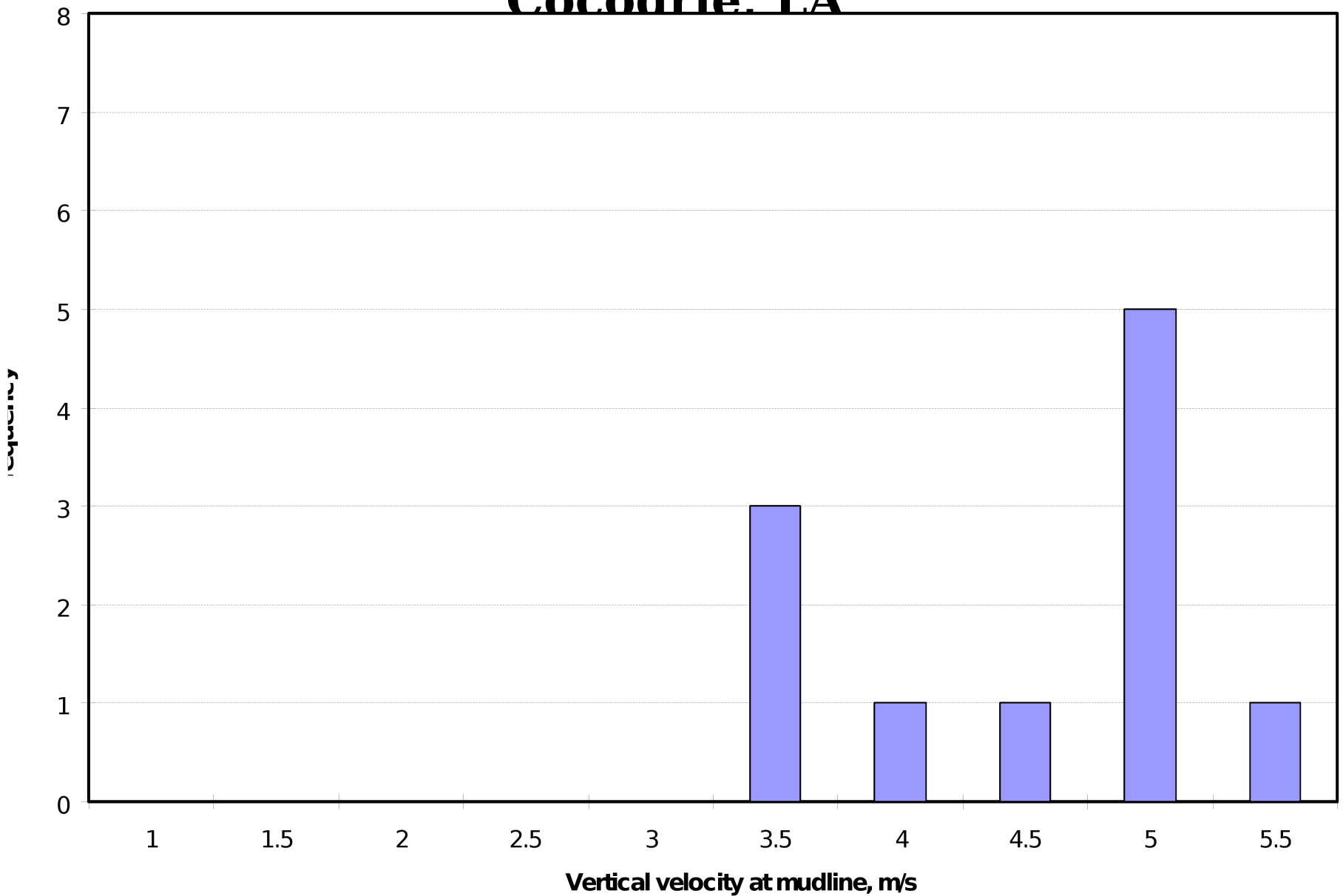
Drop #1
Released 0.5 m
below water surface



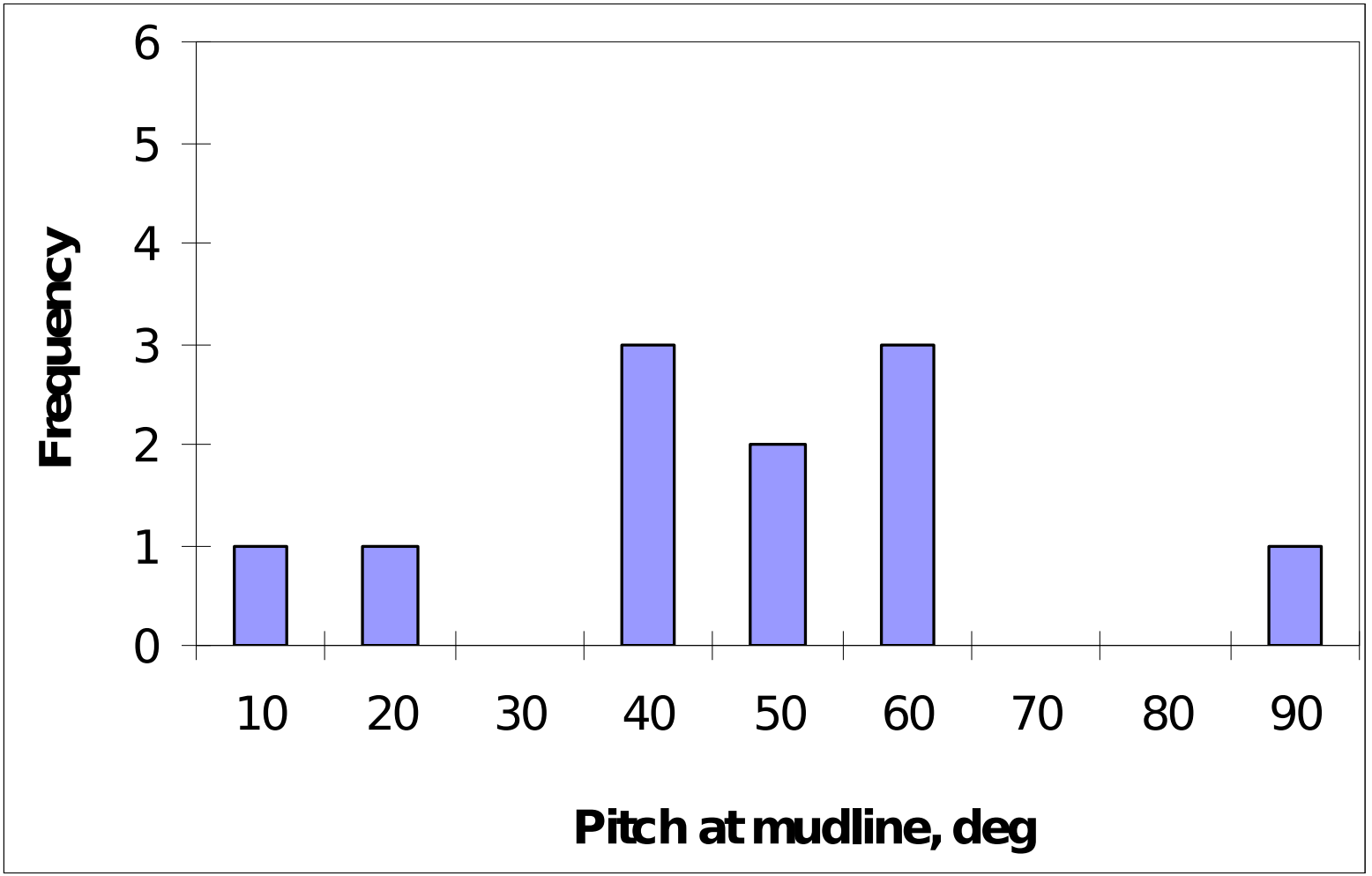
Drop #5
Released 0.5 m
above water surface



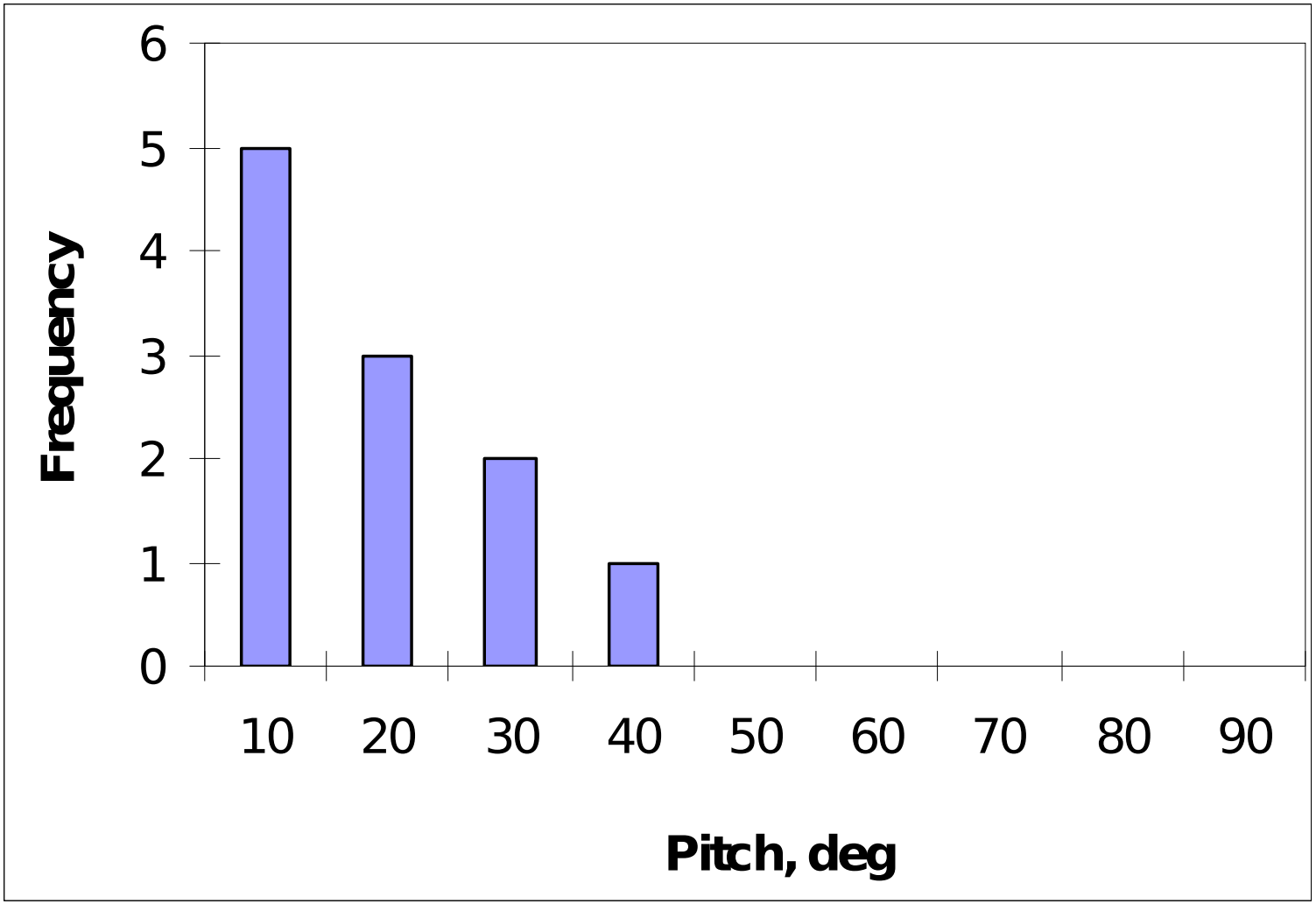
Distribution of vertical speed of cylinder approaching mudline, Cocodrie, LA



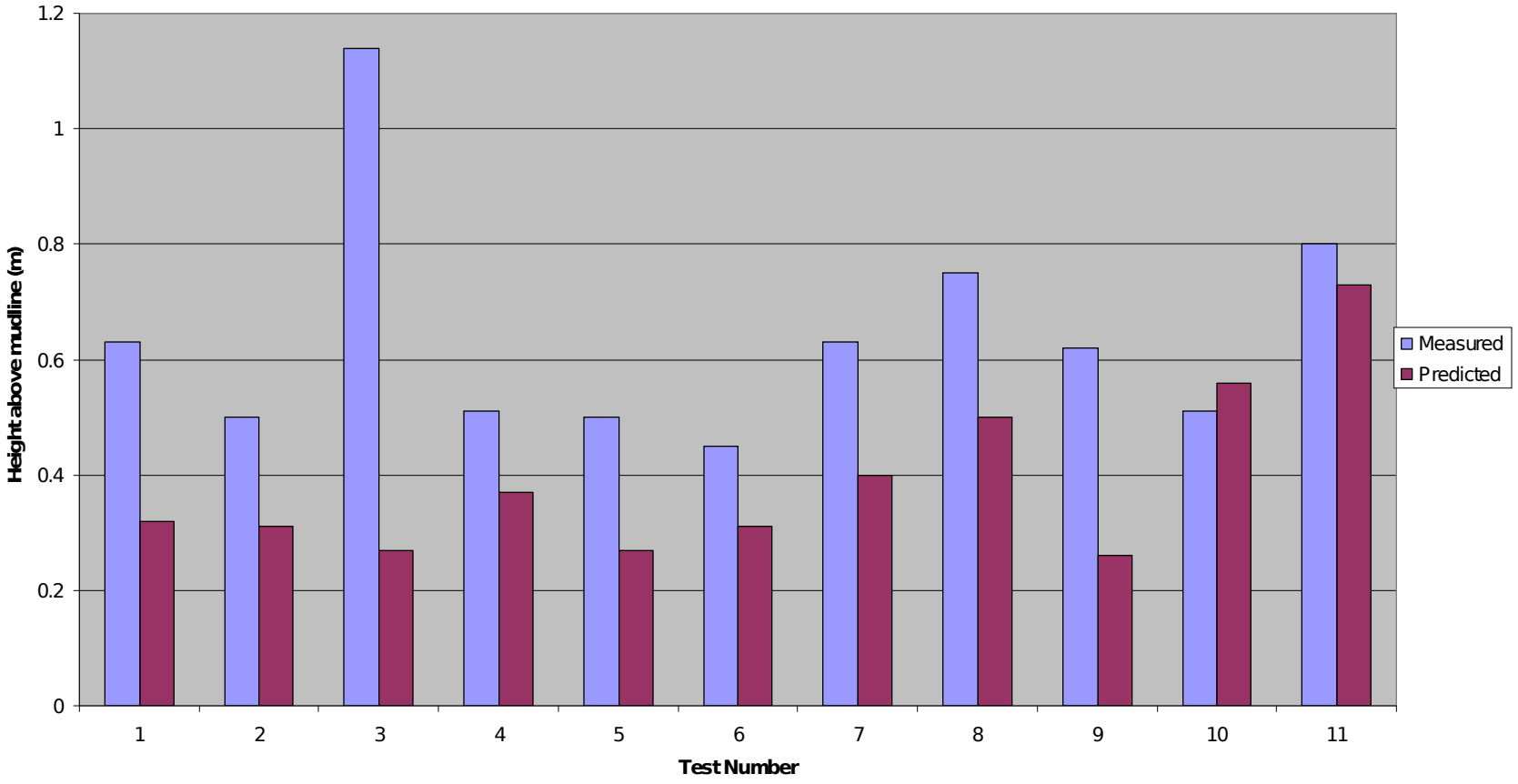
Distribution of pitch, nose down, of cylinder approaching in mud, Cocodrie, LA



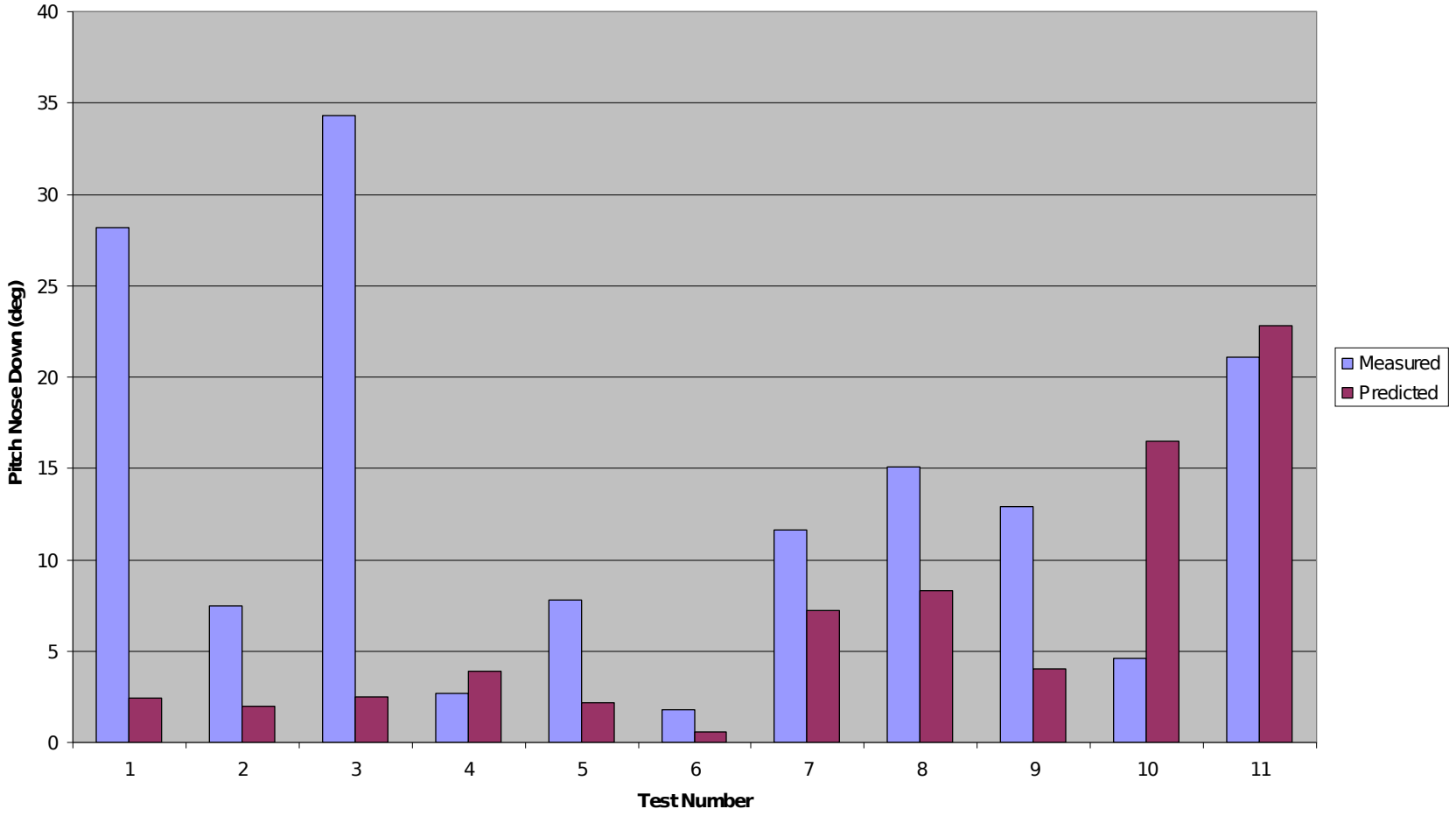
Distribution of pitch, nose down, of cylinder embedded in mud, Cocodrie, LA



Diver Measured and IMPACT28 Predicted Height Above Mudline, Cocodrie Experiment

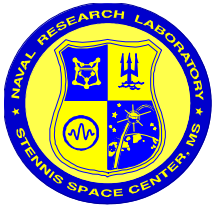


Accelerometer Measured and IMPACT28 Predicted Pitch Nose Down in Mud, Cocodrie Experiment



Summary

- A predictive model improvement in progress
- Cylinders in free-fall in water column display complex 3-D behavior
- For one site, sediment impact model:
  - underpredicts height proud
  - overpredicts change in pitch angle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Vertical Speed at Mudline Used to Initiate IMPACT28